

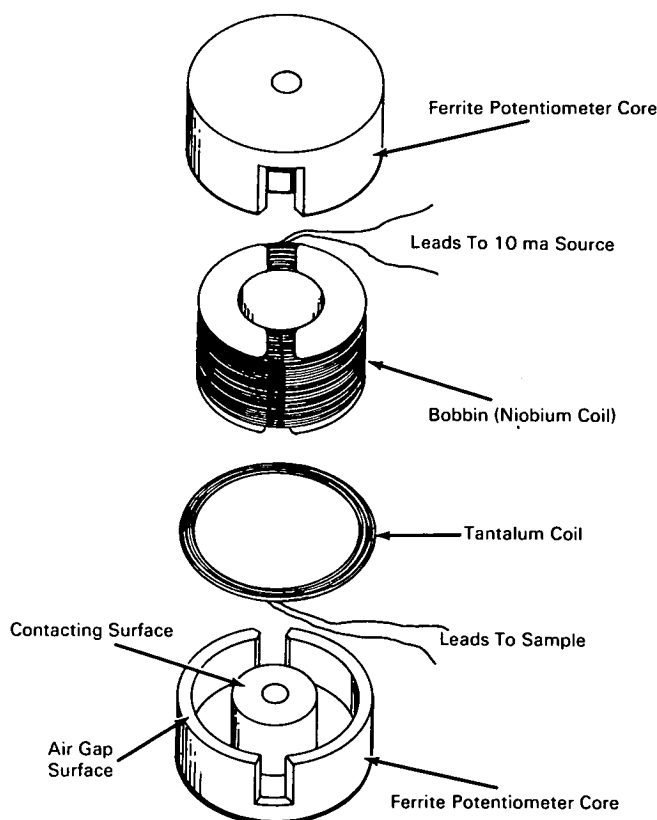


# AEC-NASA TECH BRIEF



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## Superconducting Switch Permits Measurement of Small Voltages at Cryogenic Temperatures



### The problem:

To measure small, thermoelectrically generated voltages produced by thermocouples in a liquid helium bath. Such measurements are made difficult by relatively large, spurious, thermoelectric voltages generated in the leads which connect the thermocouple (at low temperatures) with the measuring device (at room temperatures).

### The solution:

A small, dual-coil, superconducting, on-off switch placed in a shunt configuration between the thermocouple (voltage source) and the measuring device. When the switch is nonsuperconducting, the measuring device sees the sum of the voltage to be measured and the spurious thermoelectric voltages. When the switch is superconducting, only the spurious voltages

(continued overleaf)

are detected. The switch, in combination with an accurate potentiometer, will yield a sensitivity of  $1 \times 10^{-9}$  volt.

#### **How it's done:**

The switch consists of two, identical, ferrite potentiometer cores. A bobbin, placed between the potentiometer cores, carries 800 windings of 0.005-inch-diameter niobium wire. After the potentiometer cores are screwed together with the bobbin within, a coil of fine, tantalum wire is wound noninductively into the air gap between the surfaces of the potentiometer cores: 7.4 mm of 0.002-inch diameter tantalum wire is used and is separated from the niobium coil by copper foil. Both the tantalum and niobium wire are teflon-coated. The switch dimensions are 3.5 cm in diameter by 1.5 cm thick.

In operation, the switch is immersed in liquid helium outside the vacuum can of the cryostat. The tantalum coil of the switch is connected to the thermocouple within that vacuum can via short pieces of niobium wire spot-welded to the tantalum wire. With no current passing through the niobium coil, the tantalum coil is superconducting (with a resistance of  $1 \times 10^{-5}$  ohm), and the measuring device can detect only the spurious voltages. A current of 6 ma or more passed through the niobium coil activates the switch by causing the tantalum coil to pass into a nonsuperconducting state with a resistance of 45 ohms at 4.2°K. (The resistance of the tantalum coil at room

temperature is 1040 ohms.) In this state, the measuring device detects the sum of the thermocouple voltage and the spurious voltage since the tantalum coil impedance is very large relative to the output impedance of the thermocouple.

#### **Notes:**

1. Additional details may be found in *Review of Scientific Instruments*, vol. 37, no. 12, p. 1675-1676 (December 1966).
2. Inquiries concerning this innovation may be directed to:

Office of Industrial Cooperation  
Argonne National Laboratory  
9700 South Cass Avenue  
Argonne, Illinois 60439  
Reference: B68-10087

Source: R. P. Huebener and R. E. Govednik  
Solid State Sciences Division  
(ARG-90260)

#### **Patent status:**

Inquiries about obtaining rights for commercial use of this innovation may be made to:

Mr. George H. Lee, Chief  
Chicago Patent Group  
U.S. Atomic Energy Commission  
Chicago Operations Office  
9800 South Cass Avenue  
Argonne, Illinois 60439